Update on aircraft validation efforts; T/q retrieval validation using ARM data

Dave Tobin, Leslie Moy, Bob Knuteson, Hank Revercomb, Fred Best, Joe Taylor
CIMSS / SSEC / UW-Madison

AIRS Science Team Meeting
Pasadena, CA
27-30 March 2007

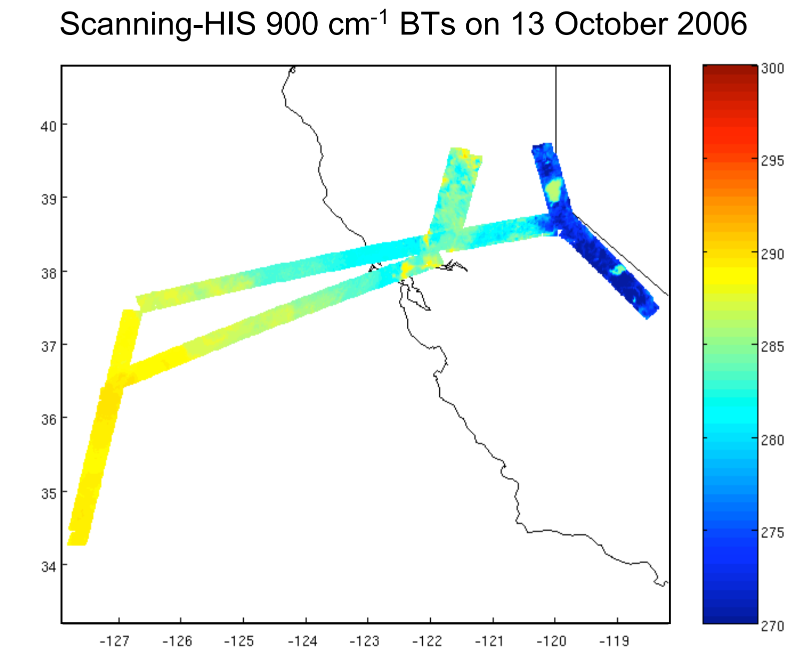
➢ Thanks to the AIRS Project @ JPL, Joe Rice and Joe O'Connell (NIST), Dave Starr (NASA), Barry Lesht (ARM), Chris Barnet (NOAA), and Scott Hannon (UMBC)

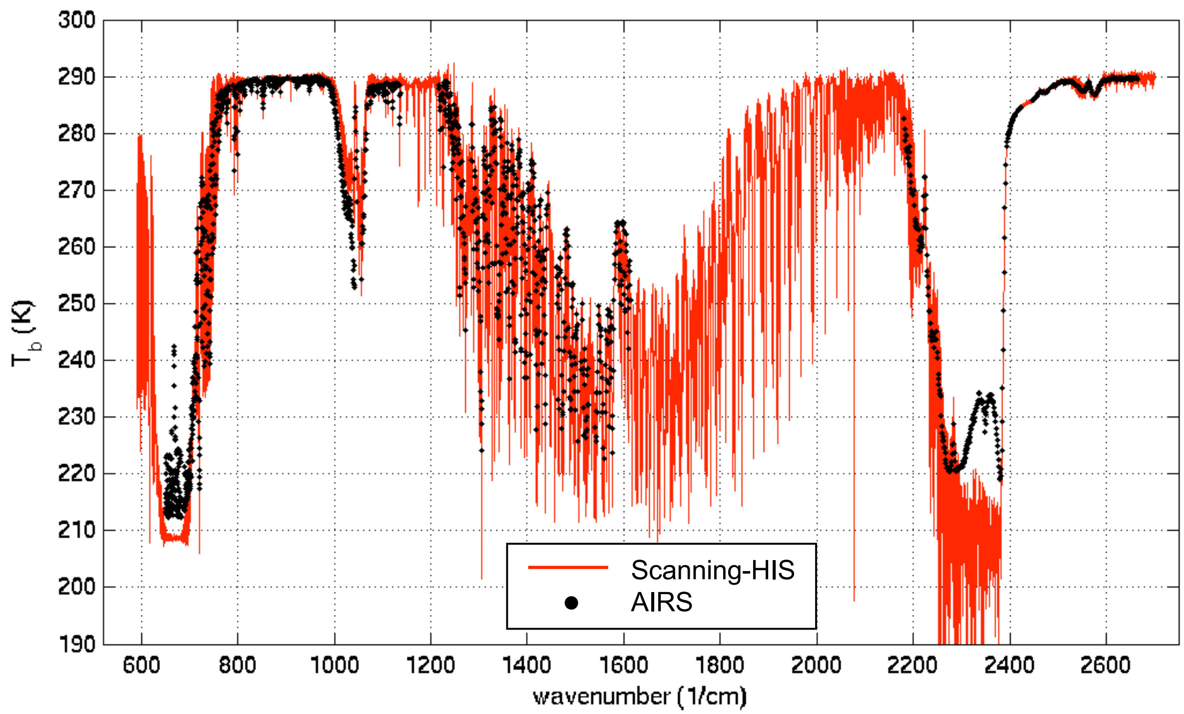
Topics

- Update on aircraft validation efforts
  - NIST TXR / Scanning-HIS direct radiance tests
  - NIST TXR / Scanning-HIS blackbody emissivity tests
  - Near term plans

- T/q profile retrieval validation using ARM site observations
  - v5 profile assessments and comparison to v4
  - v5 retrieval performance over land; relation to retrieved surface emissivity

Aircraft based Scanning-HIS observations used to validate the AIRS spectral radiances

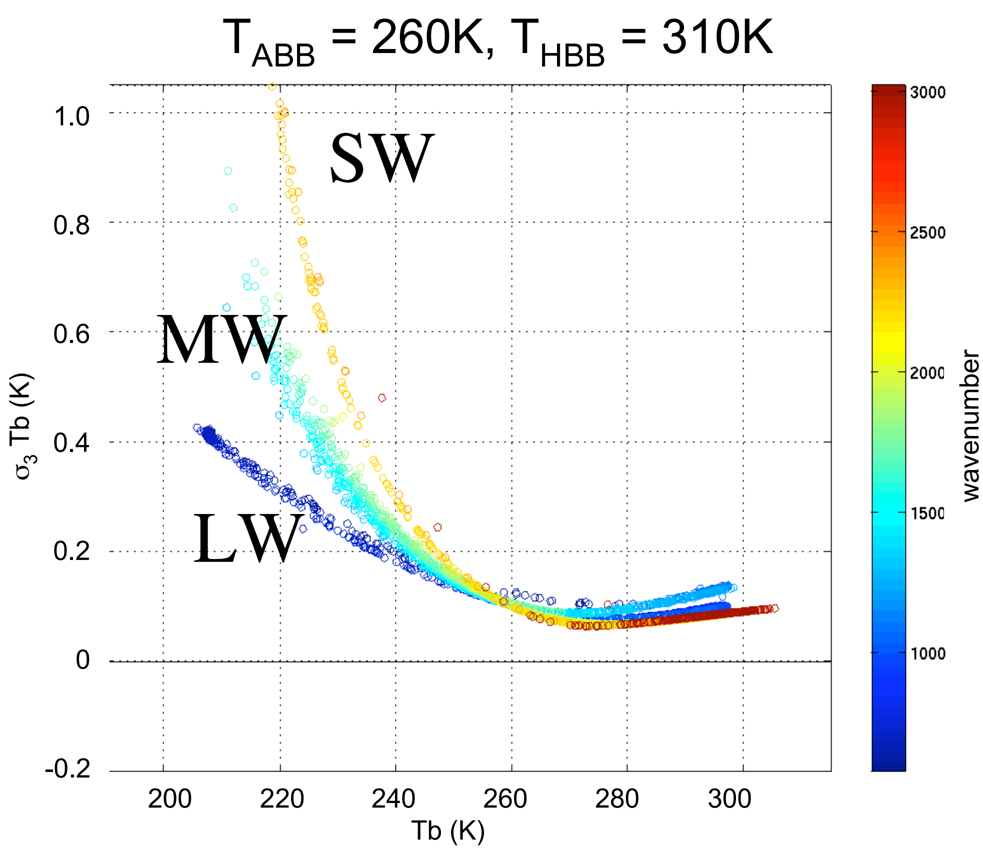




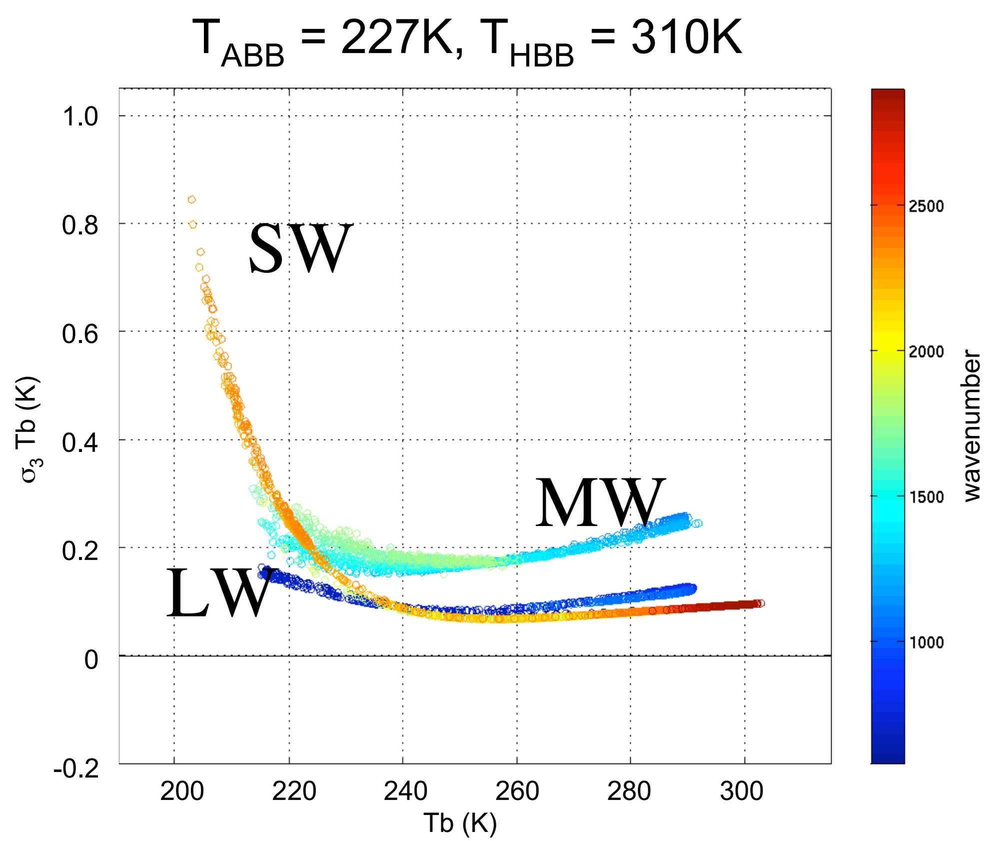
Tobin et al. (2006), Radiometric and spectral validation of Atmospheric Infrared Sounder observations with the aircraft-based Scanning High-Resolution Interferometer Sounder, J. Geophys. Res., 111, D09S02, doi:10.1029/2005JD006094.

Vinson et al. (2006), Techniques used in improving the radiance validation of Atmospheric Infrared Sounder observations with the Scanning High- Resolution Interferometer Sounder, Proc. SPIE Vol. 6405.

Scanning-HIS Radiometric Calibration
3-sigma Uncertainty Budget



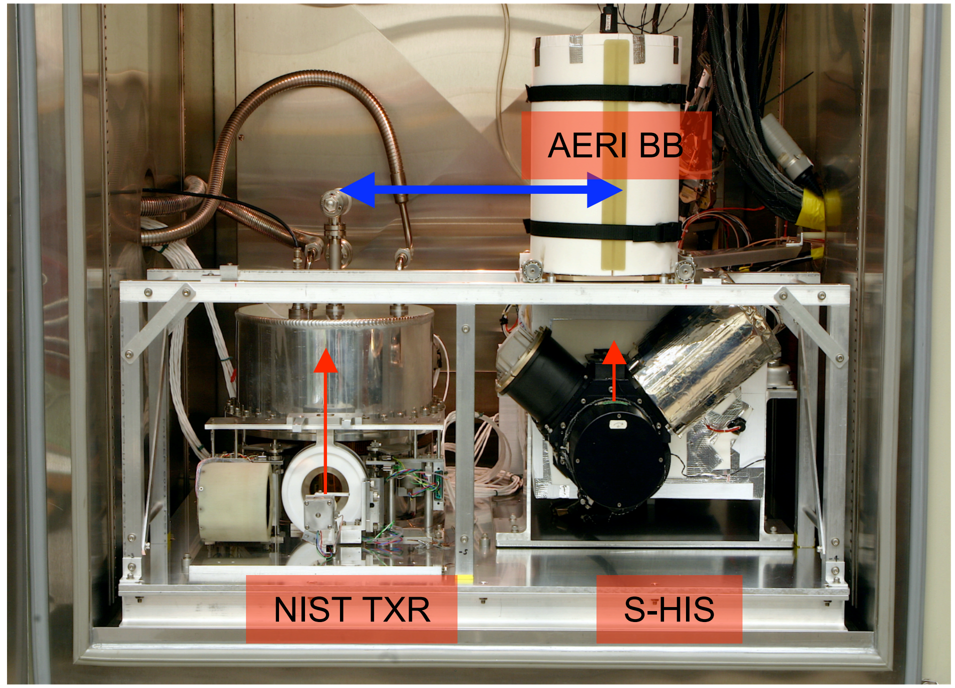
21 November 2002
on ER2



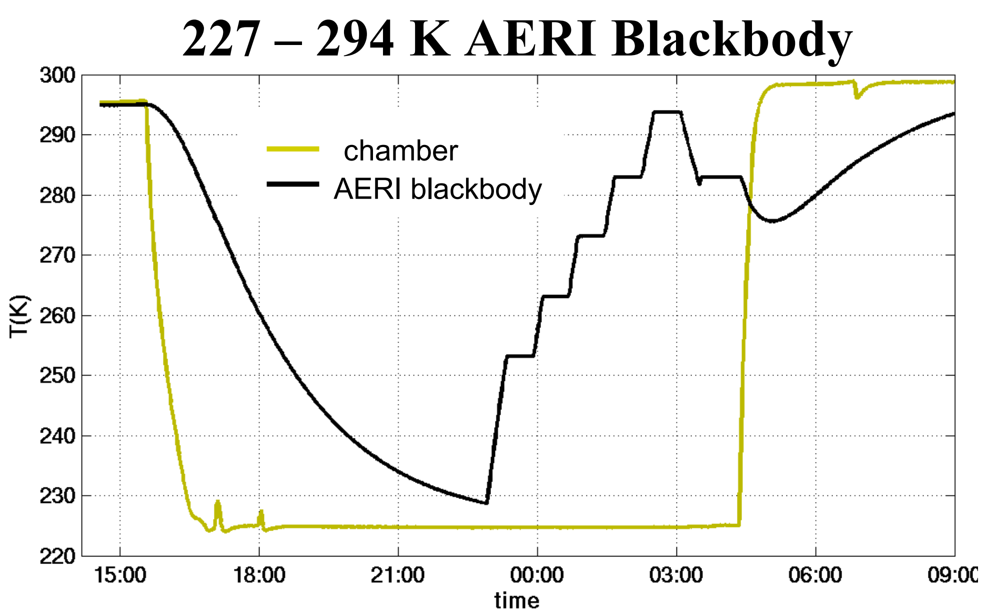
16 November 2002
on Proteus

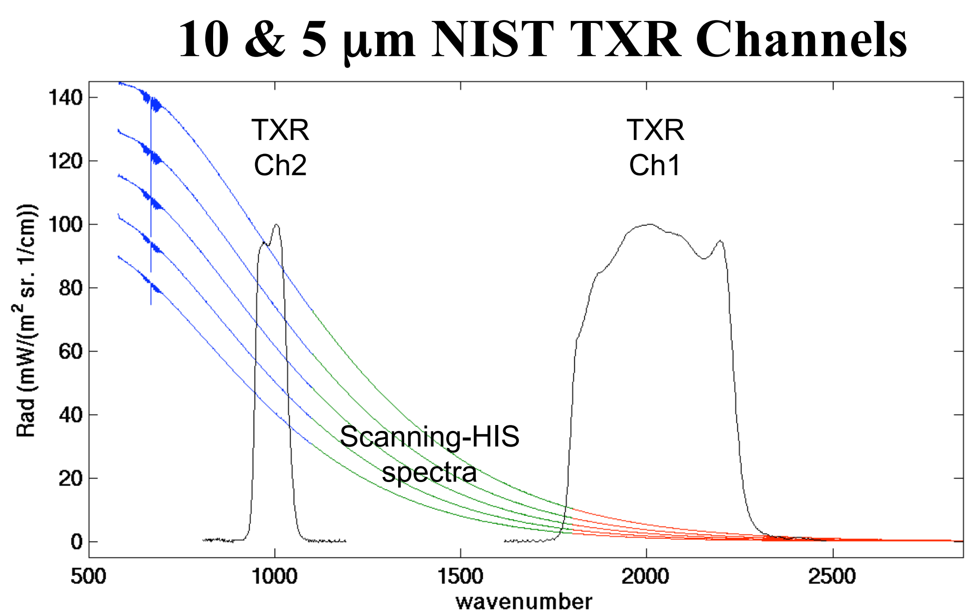
NIST TXR / Scanning-HIS Radiance Test

Recent end-to-end radiance evaluations conducted under S-HIS flight-like conditions with the NIST Transfer Radiometer (TXR) such that S-HIS satellite validation & AERI observations are traceable to the NIST radiance scale

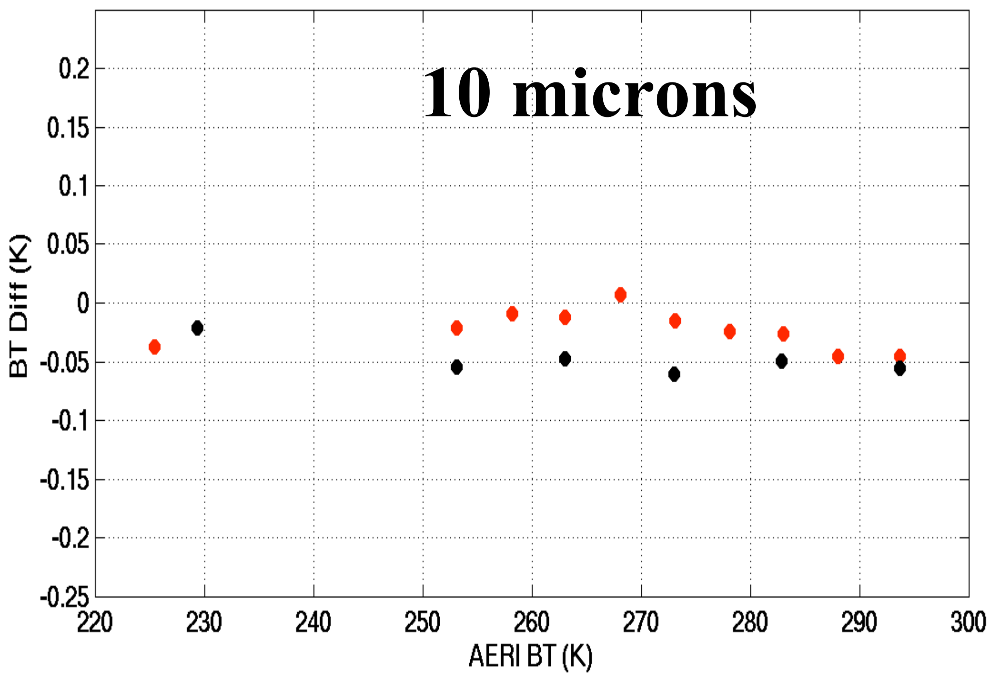


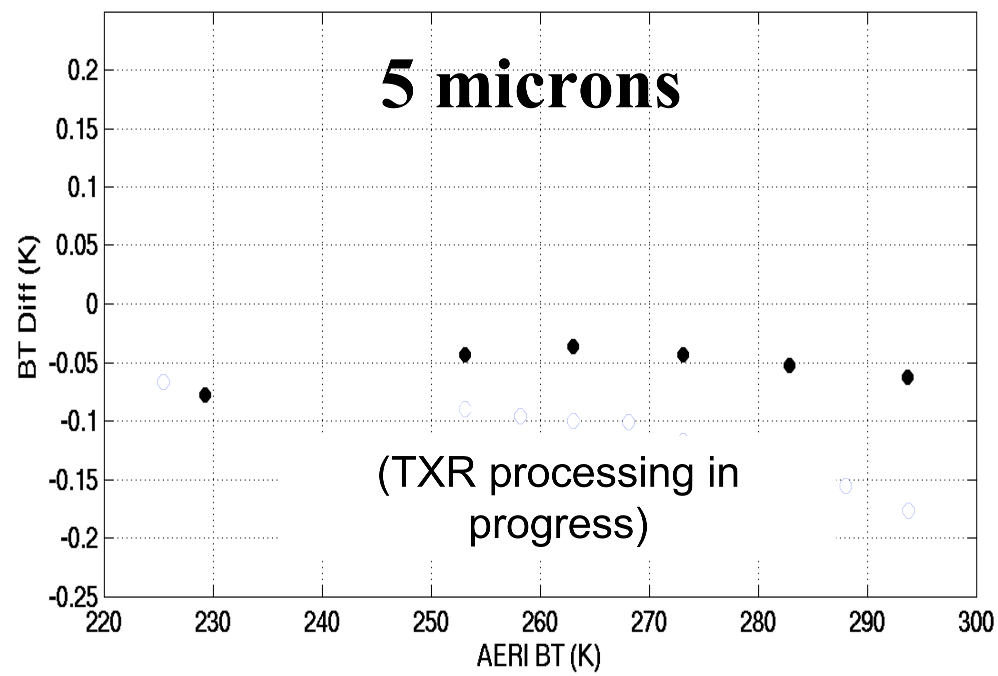
January 2007, testing at UW/SSEC





Preliminary S-HIS/NIST 5 and 10 μm results



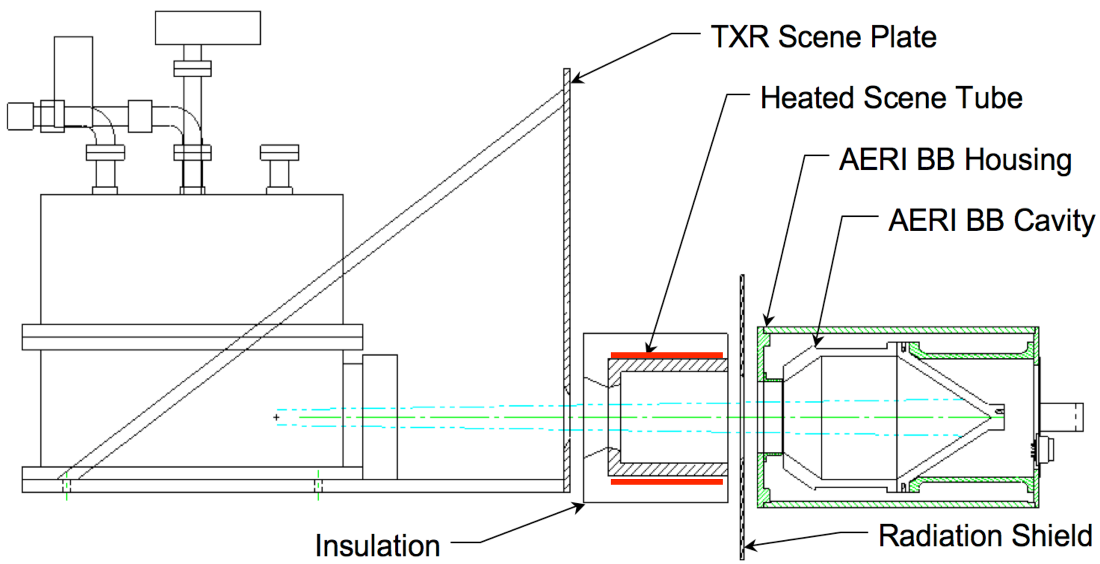


- AERI BB minus TXR
- AERI BB minus S-HIS

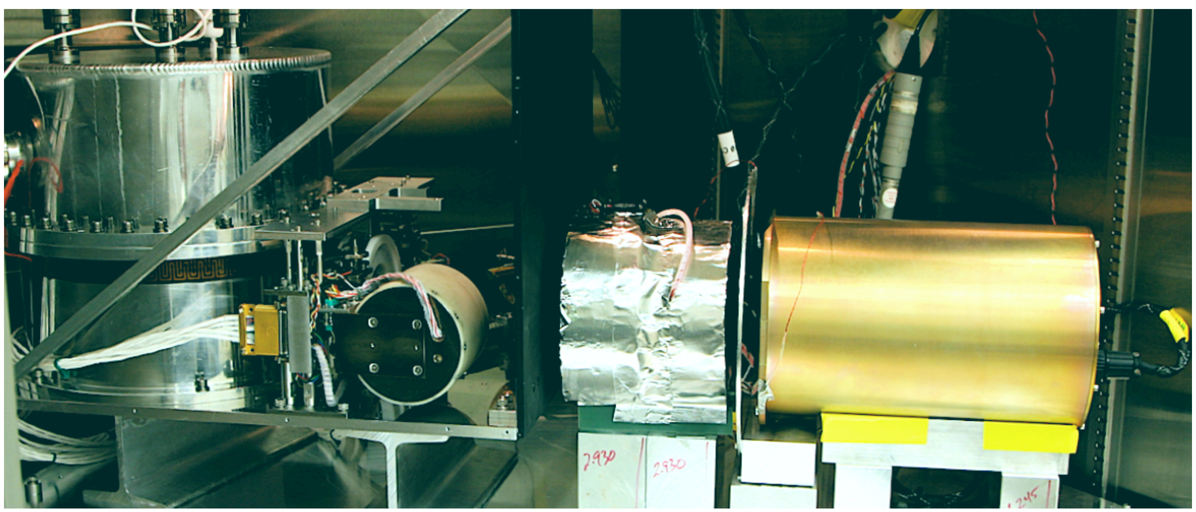
- AERI BB & S-HIS agree to about **50 mK**
- NIST TXR & S-HIS agree to about **30 mK**
- Well within propagated 3-sigma uncertainty estimates

Recent AERI Blackbody Reflectivity Test with NIST TXR Confirms Emissivity Estimates

$$R = \varepsilon_{BB}\, B(T_{BB}) + (1-\varepsilon_{BB})[F \bullet B(T_{Tube}) + (1-F) \bullet B(T_{BG})]$$



NIST Transfer Radiometer (TXR) used to detect reflection from heated tube (up to background +100 ºC) surrounding direct FOV



January 2007

<u>Preliminary Analysis</u>:
5 & 10 μm emissivity
within <0.0003
of expected value
(and closer to 1)

S-HIS, Near term AIRS underflight opportunities

- JAIVEx
  - Joint Airborne IASI Validation Experiment
  - 14 April to 4 May out of Houston, TX

- TC4
  - Tropical Composition, Clouds and Climate Coupling Experiment
  - July/August out of San Jose, Costa Rica

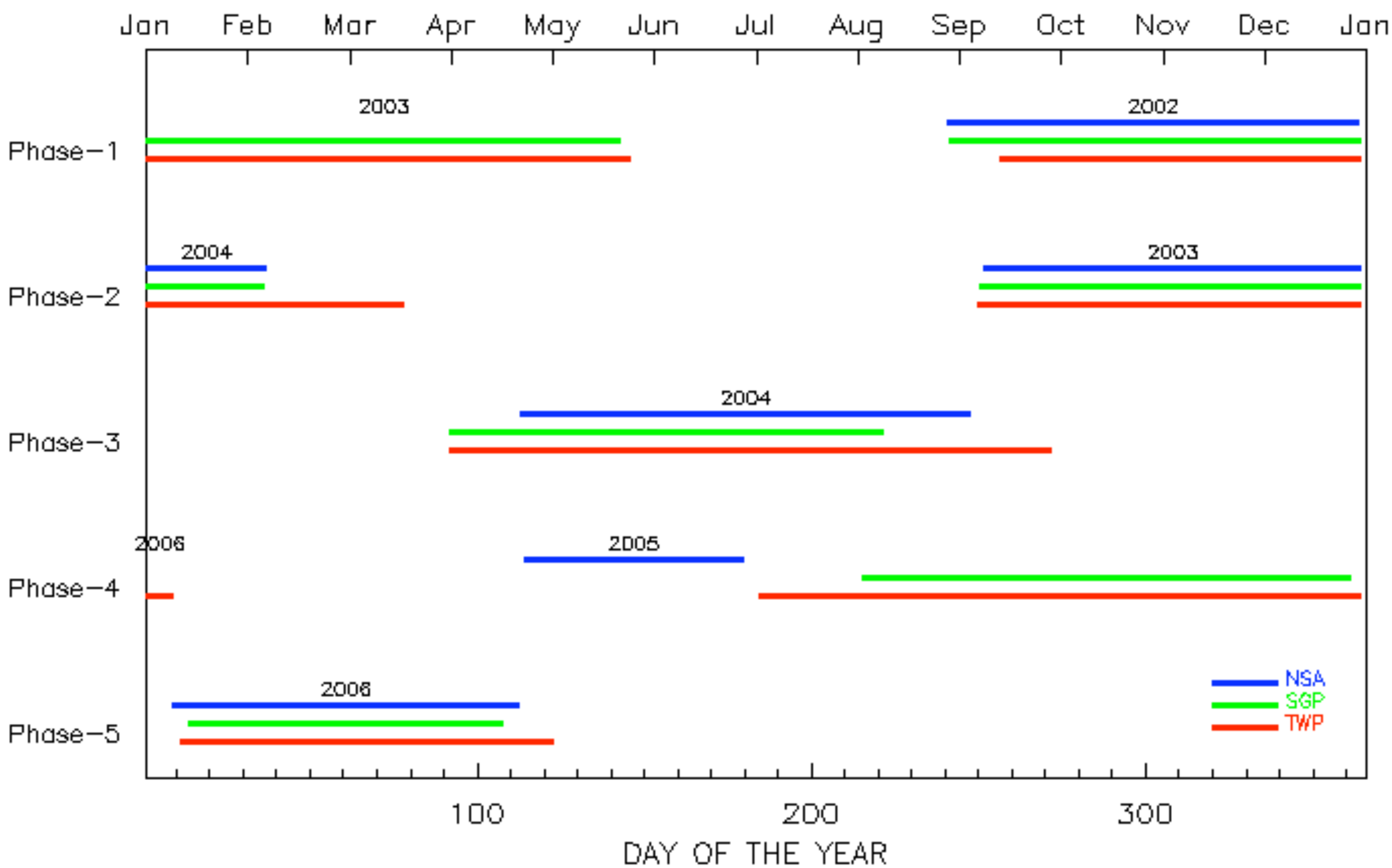
T/q profile retrieval validation using ARM site observations

- Characterization of the retrieval performance at three climatically relevant ground validation sites

- Approach and v4 results in: Tobin et al. (2006), Atmospheric Radiation Measurement site atmospheric state best estimates for Atmospheric Infrared Sounder temperature and water vapor retrieval validation, J. Geophys. Res., 111, D09S14, doi:10.1029/2005JD006103.

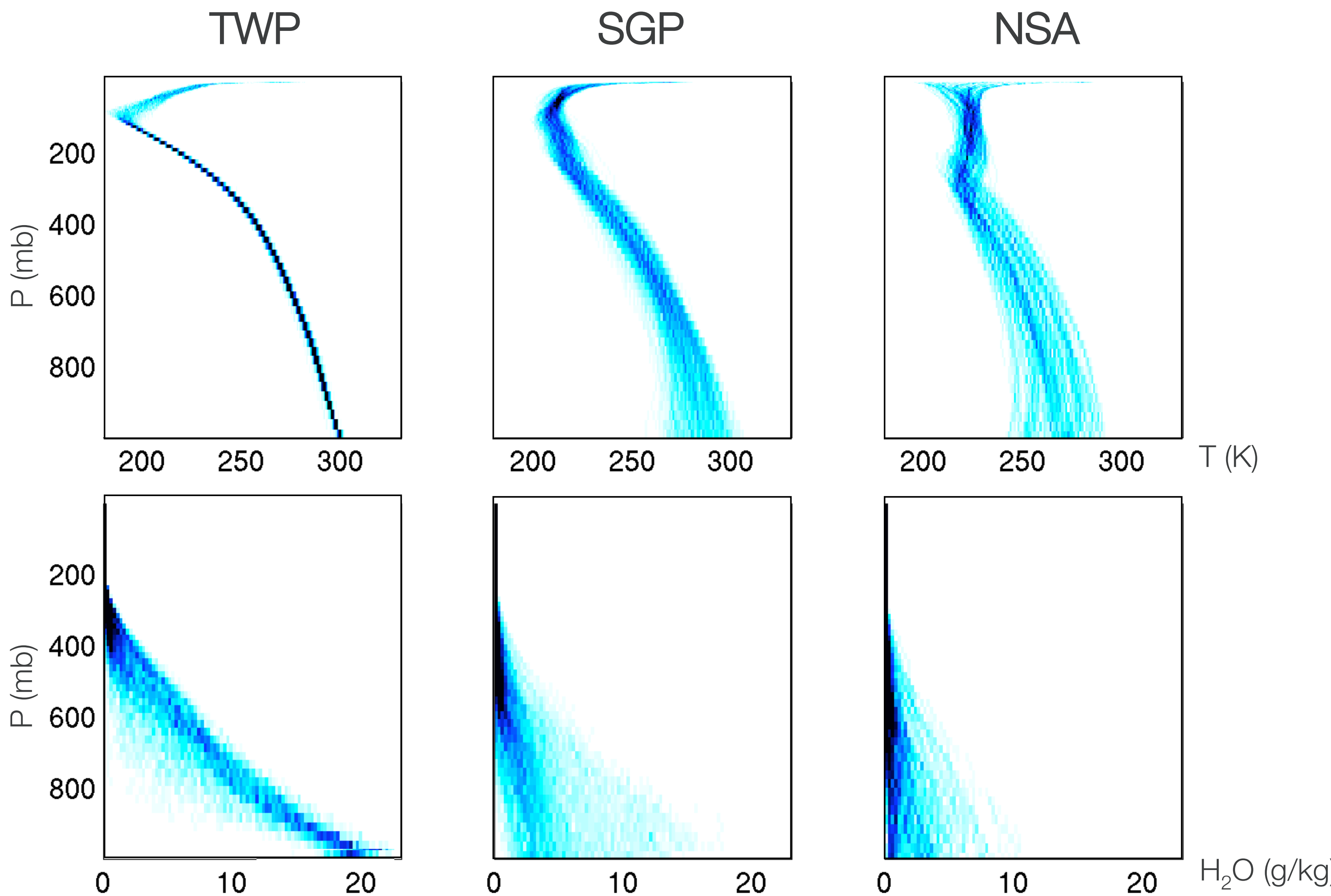
Atmospheric Radiation Measurement (ARM) Sites

AIRS Dedicated Radiosonde Launch Phases



5 “phases” conducted to date. 90 overpasses sampled from each site for phases 1 thru 4; 60 in Phase 5.

Temperature and Water Vapor Profile Distributions

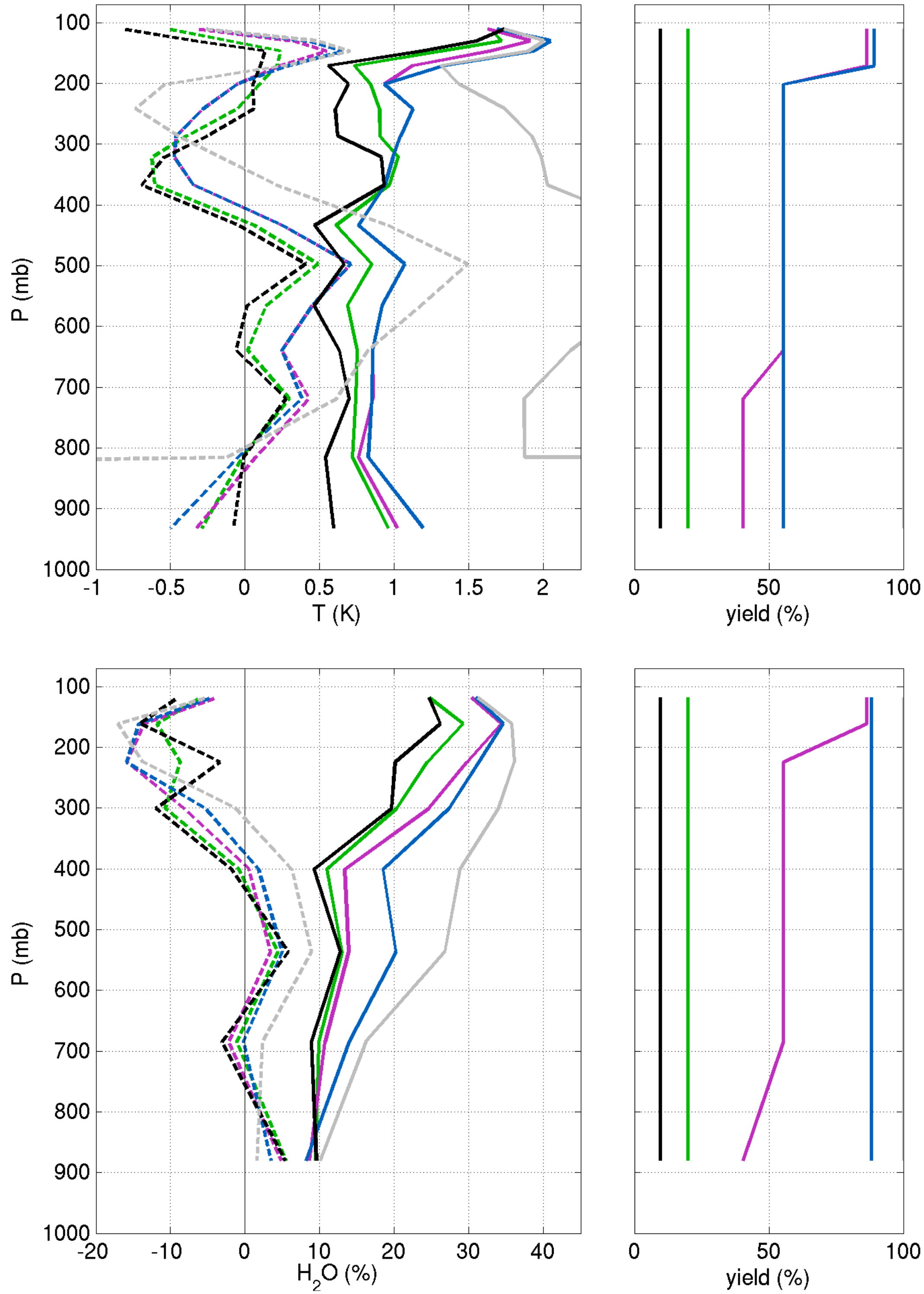


TWP, v4
AIRS - ARM

Grey:	All cases
Blue:	Temperature accepted; H2O accepted
Purple:	Temperature and H2O accepted
Green:	Temperature at all levels, H2O, and Surface* accepted
Black:	Temperature at all levels, H2O, and Surface* best quality

Dashed: Bias
Solid: RMS

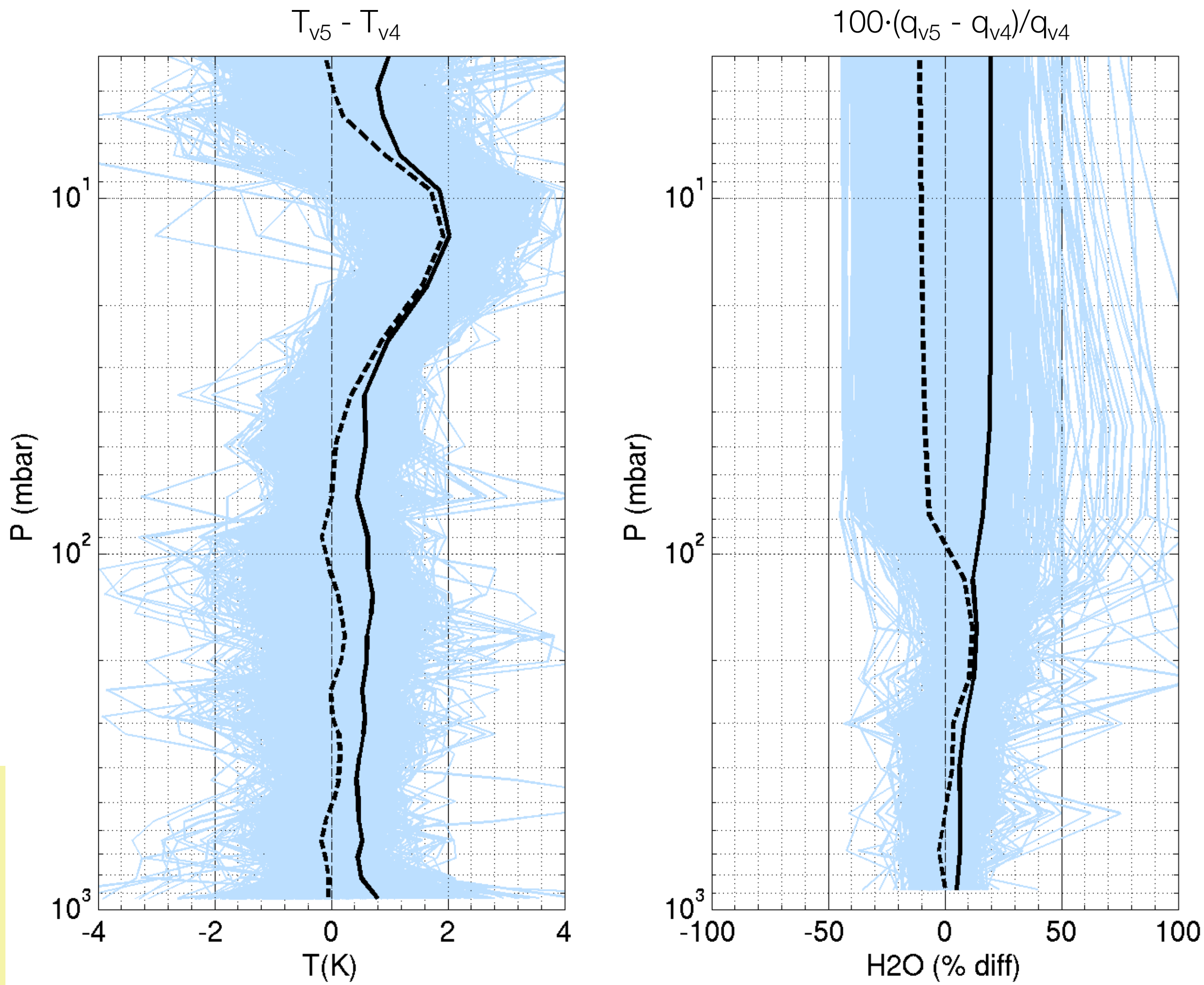
- T and q RMS performance is generally very good and QC dependent
- T bias: oscillations
- Q bias: Retrievals are 10-15% dryer in upper trop



TWP, differences between v4 and v5

Dashed: Bias
Solid: RMS

v5 Pgood @ surface



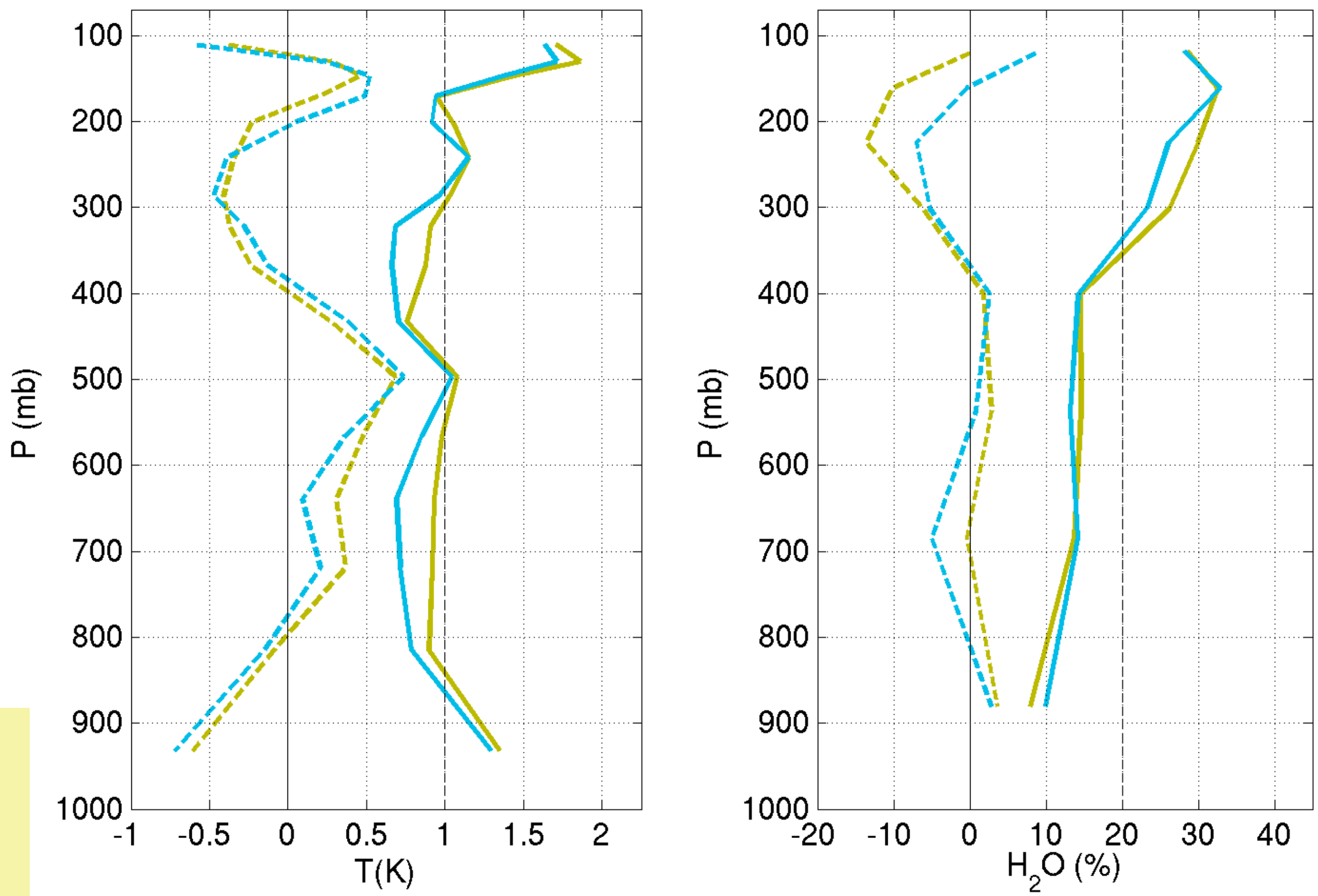
- T biases changes: largely unchanged in lower trop
- q biases changes: v5 is slightly dryer in lower trop and moister by 10-15% in upper trop

TWP, v5-ARM and v4-ARM using v5 QC

v4
v5

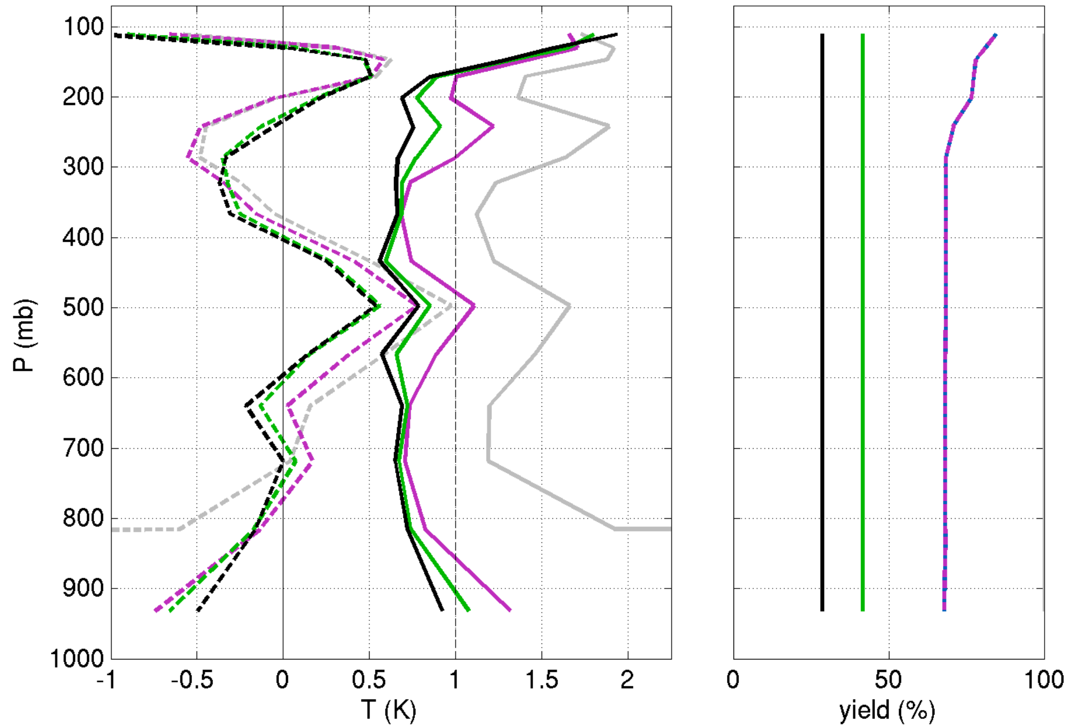
Dashed: Bias
Solid: RMS

v5 Pgood @ surface



- v5 T RMS improved over v4
- v5 q RMS performance slightly improved in upper trop
- T biases largely unchanged
- q bias reduced in upper trop

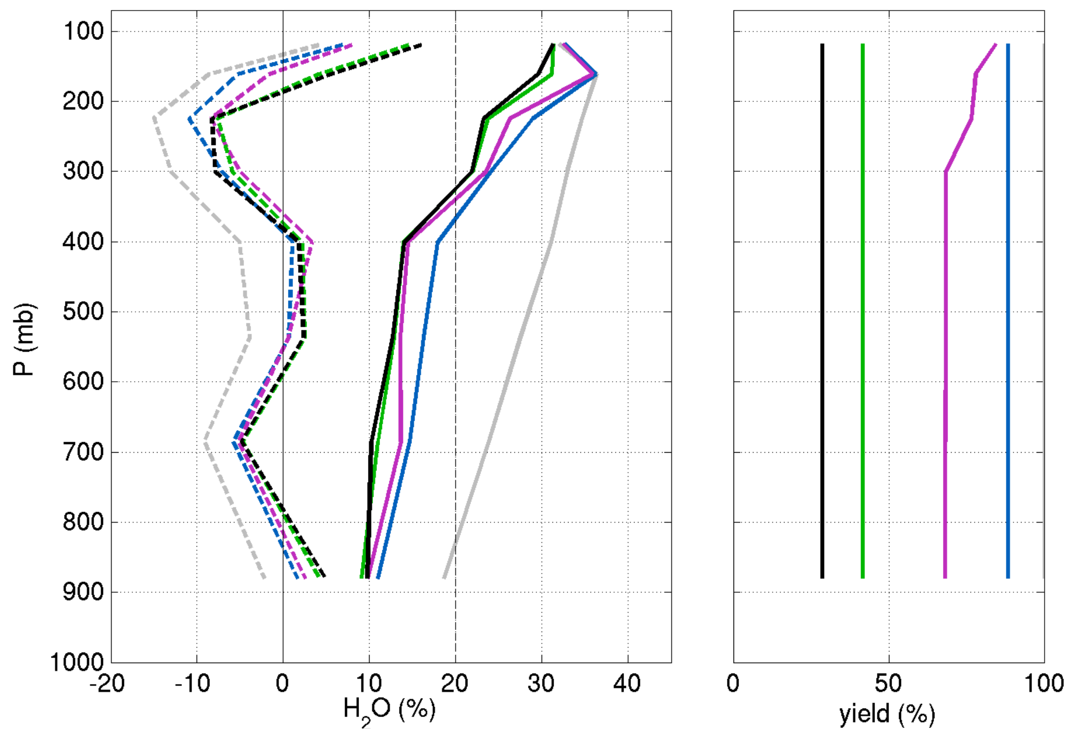
TWP, v5
AIRS - ARM



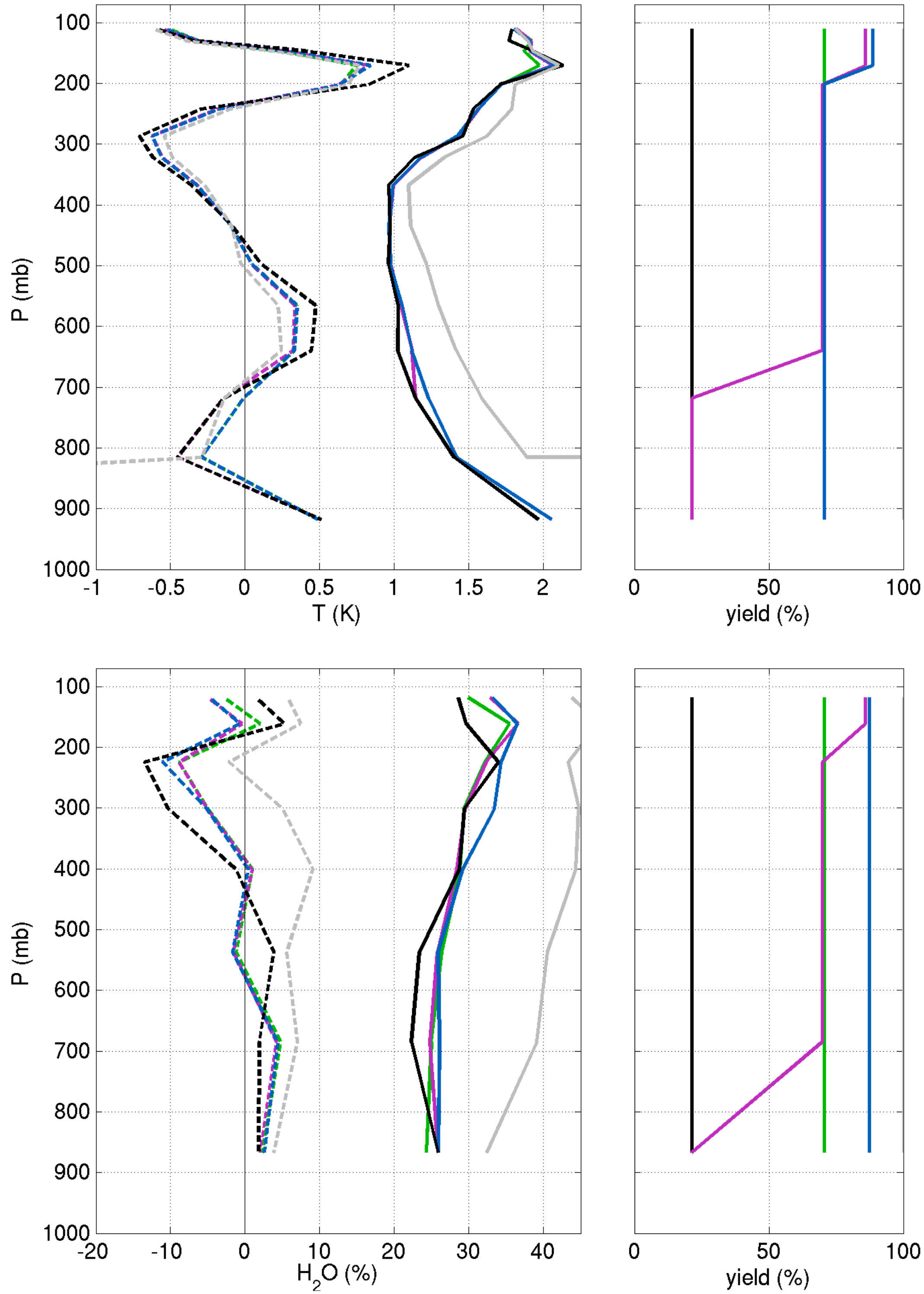
Grey: All cases
Blue: Temperature accepted; H2O accepted
Purple: Temperature and H2O accepted
Green: Temperature at all levels, H2O, and Surface* accepted
Black: Temperature at all levels, H2O, and Surface* best quality

Dashed: Bias
Solid: RMS

- Similar RMS performance to v4
- Increased yields



SGP, v4
AIRS - ARM



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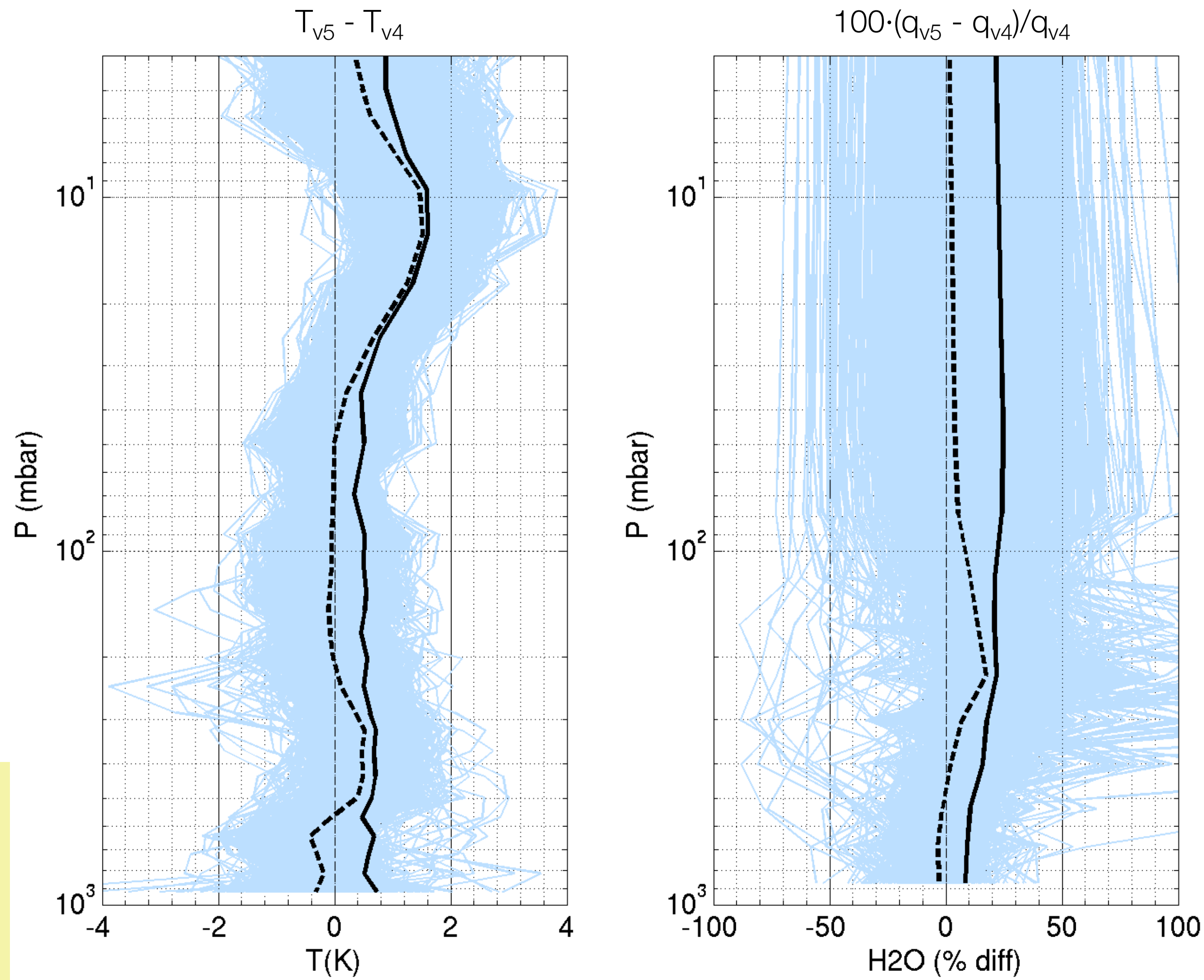
Dashed: Bias
Solid: RMS

- RMS for T and q degraded w/r/t TWP (e.g. 2 K RMS at 900 mb, > 25% q through troposphere) and largely independent of QC
- T bias: oscillations
- q bias: similar to TWP

SGP, differences between v4 and v5



Dashed: Bias
Solid: RMS

v5 Pgood @ surface

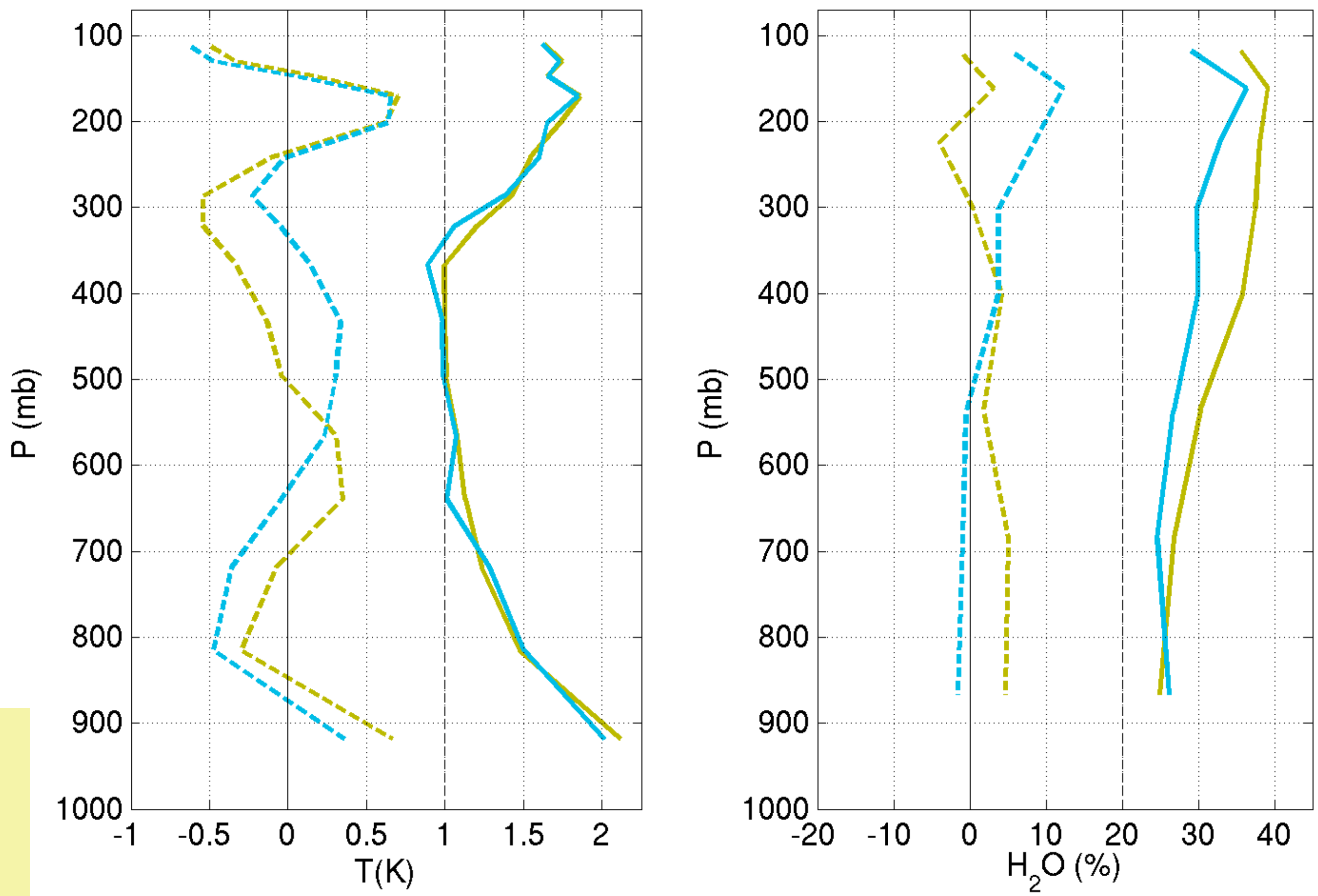
- T bias changes: v5 is colder in lower trop, warmer in upper trop
- Q bias changes: similar to TWP, v5 is slightly dryer in lower trop and 10-15% moister in upper trop

SGP, v5-ARM and v4-ARM using v5 QC

v4
v5

Dashed: Bias
Solid: RMS

v5 Pgood @ surface



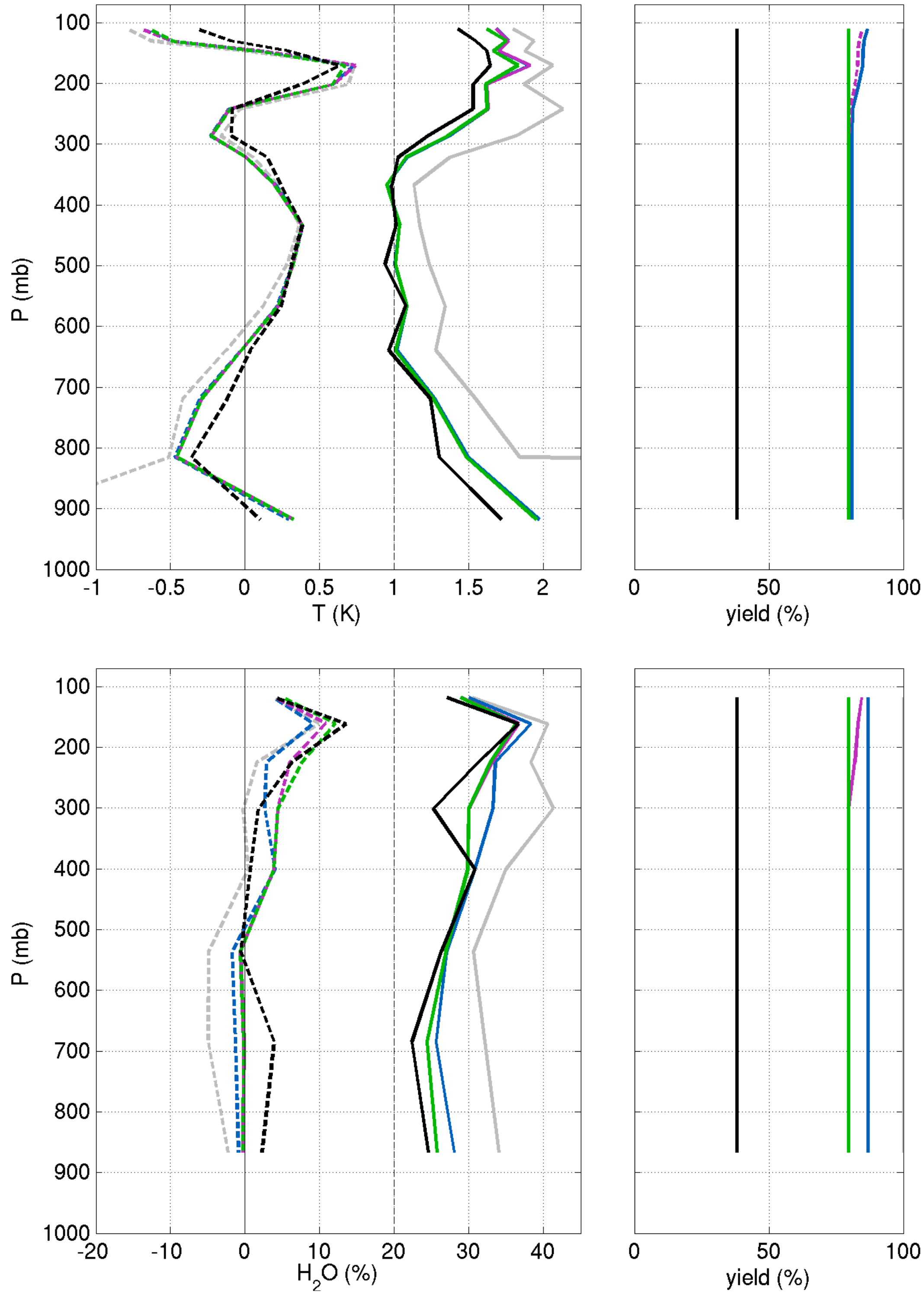
- T RMS largely unchanged from v4 to v5
- v5 q RMS is much improved over v4 above 700 mbar
- T bias: changes
- q bias: v5 bias is near zero in lower trop, ~10% moister than ARM in upper trop

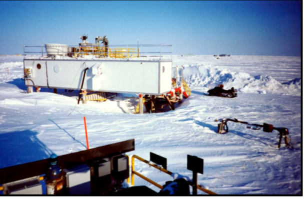
SGP, v5
AIRS - ARM

Grey: All cases
Blue: Temperature accepted; H2O accepted
Purple: Temperature and H2O accepted
Green: Temperature at all levels, H2O, and Surface* accepted
Black: Temperature at all levels, H2O, and Surface* best quality

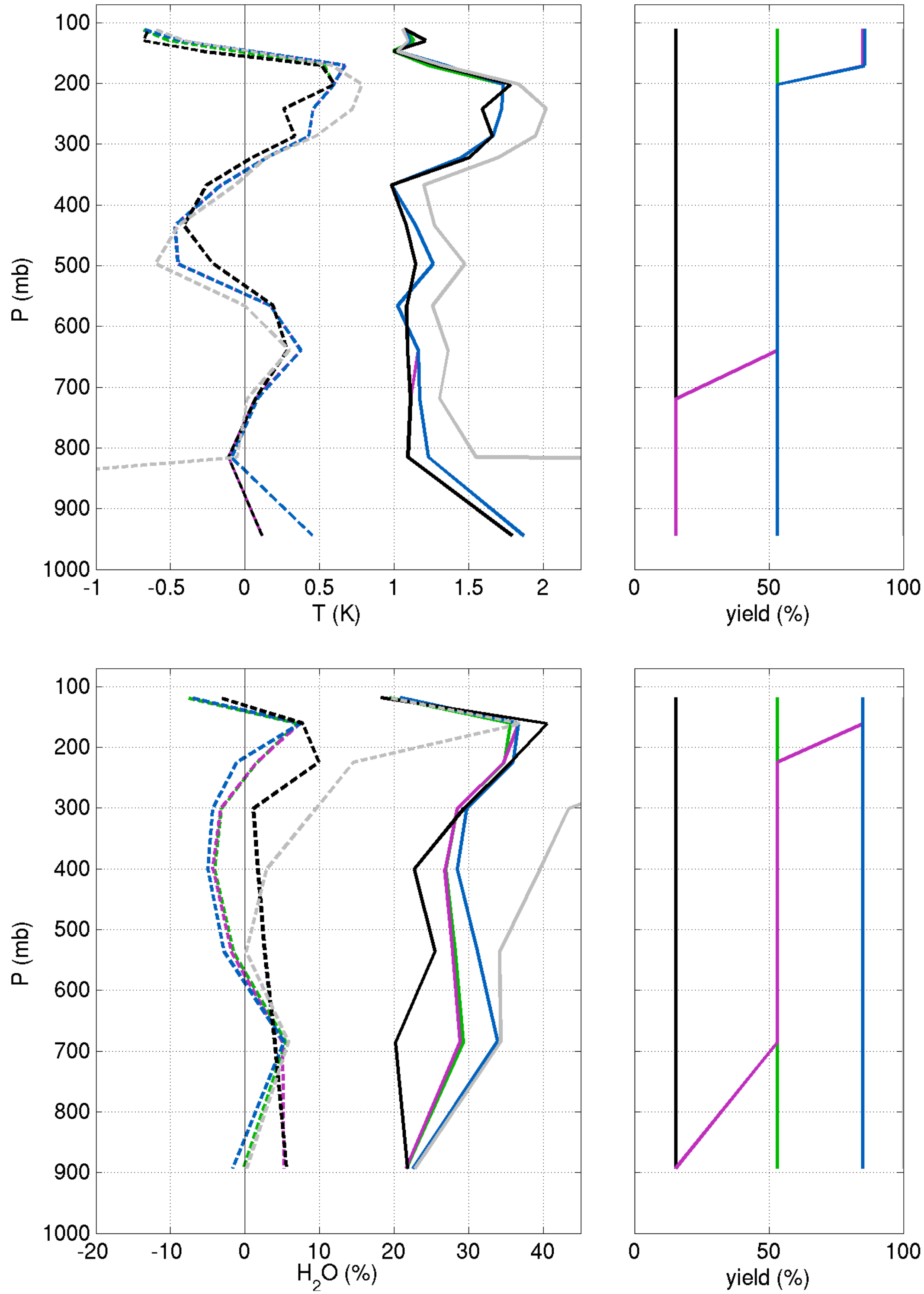
Dashed: Bias
Solid: RMS

- T RMS for best QC ensemble is improved, and with higher yields over v4
- Q RMS is improved in upper trop and with higher yields than v4
- Still not generally meeting the 1K/1km and 20%/2km objectives





NSA, v4
AIRS - ARM



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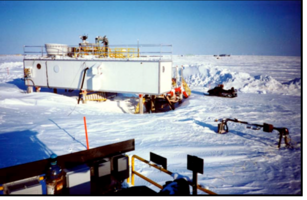
Dashed: Bias
Solid: RMS

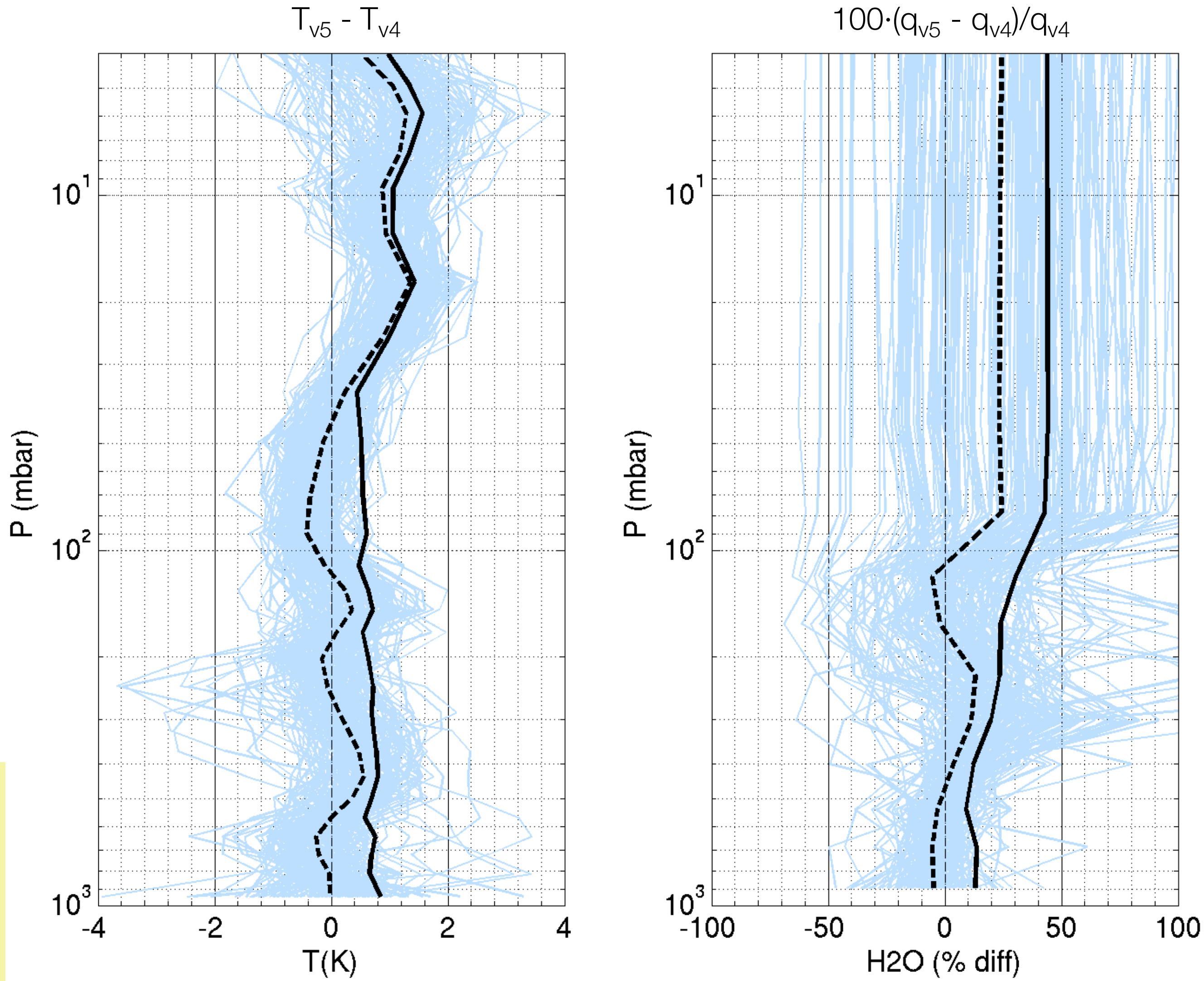
- RMS performance for T and q is very simialr to that at SGP site (!)
- Somewhat degraded performance in isothermal upper trop



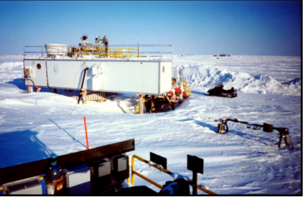
NSA, differences between v4 and v5

Dashed: Bias
Solid: RMS

v5 Pgood @ surface



- T bias changes: v5 is colder in lower trop and warmer in upper trop
- q bias changes: v5 is drier in lower trop, moister in upper trop
- v5 q has much less variability in upper trop



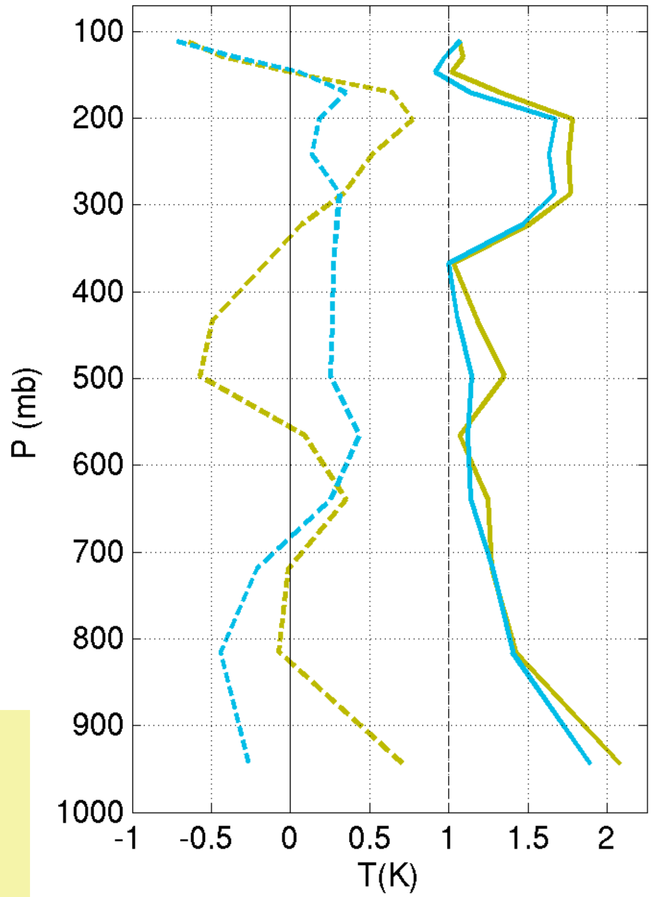
NSA, v5-ARM and v4-ARM using v5 QC

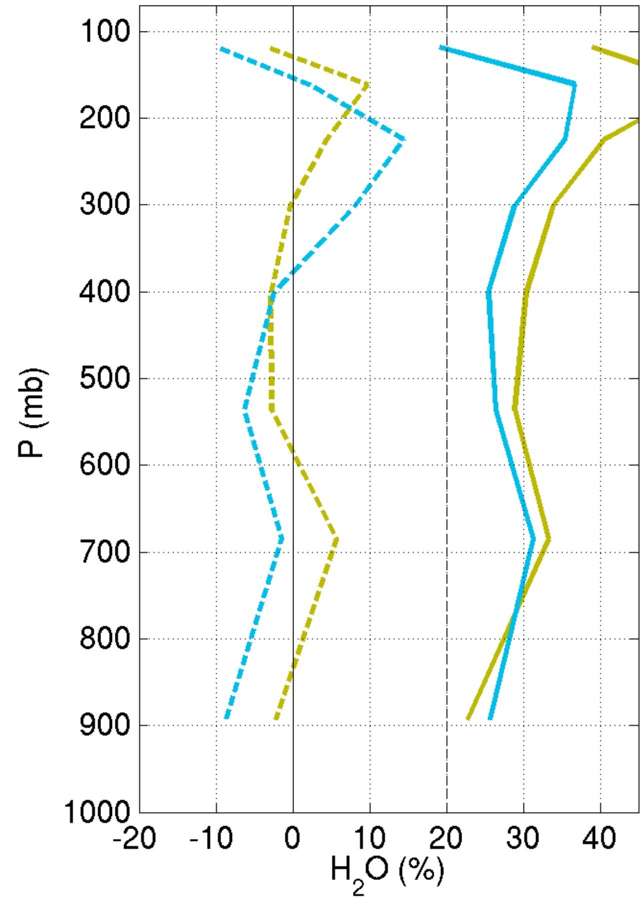
v4
v5

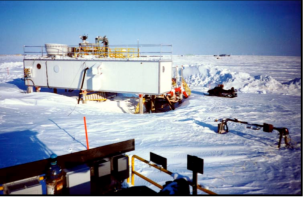
Dashed: Bias
Solid: RMS

v5 Pgood @ surface

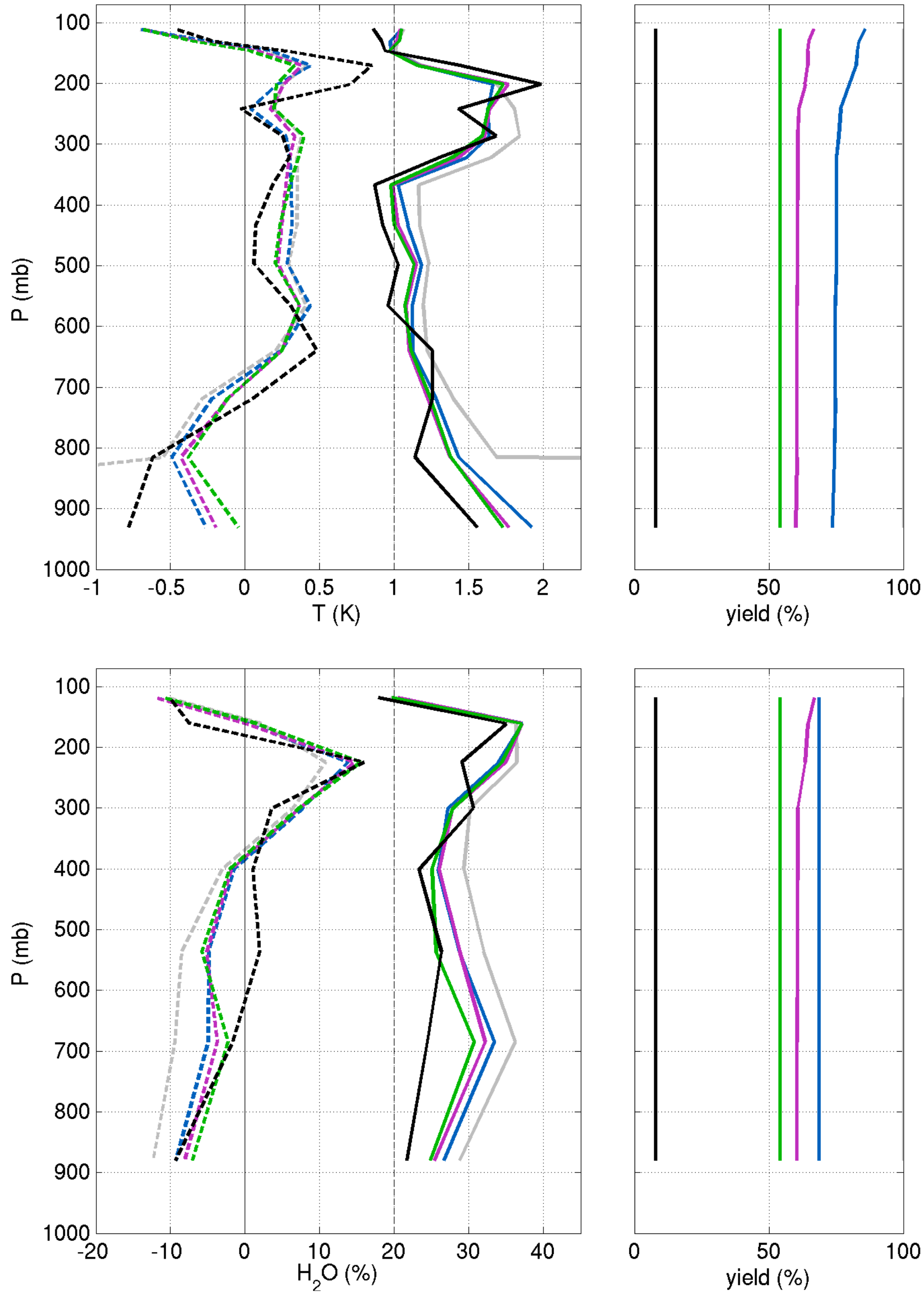
- T RMS largely unchanged from v4 to v5
- q RMS much improved above 700 mbar







NSA, v5
AIRS - ARM



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Black:	Temperature at all levels, H2O, and Surface* best quality

Dashed: Bias
Solid: RMS

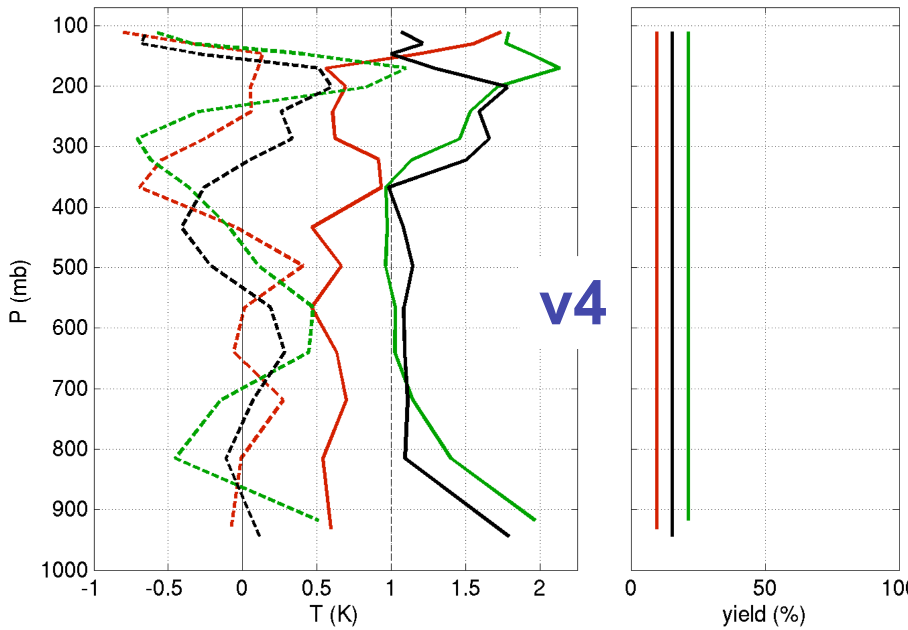
- RMSs similar to SGP, but slightly better T RMS in lower trop
- 5 to 10% q bias below 400 mbar (AIRS drier than ARM)

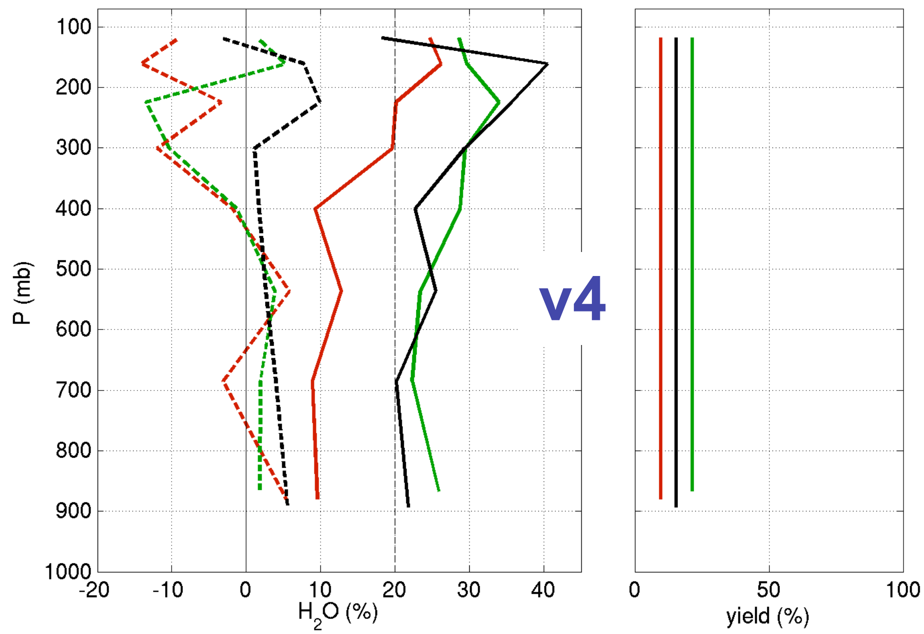
Summary, Best Quality Retrievals

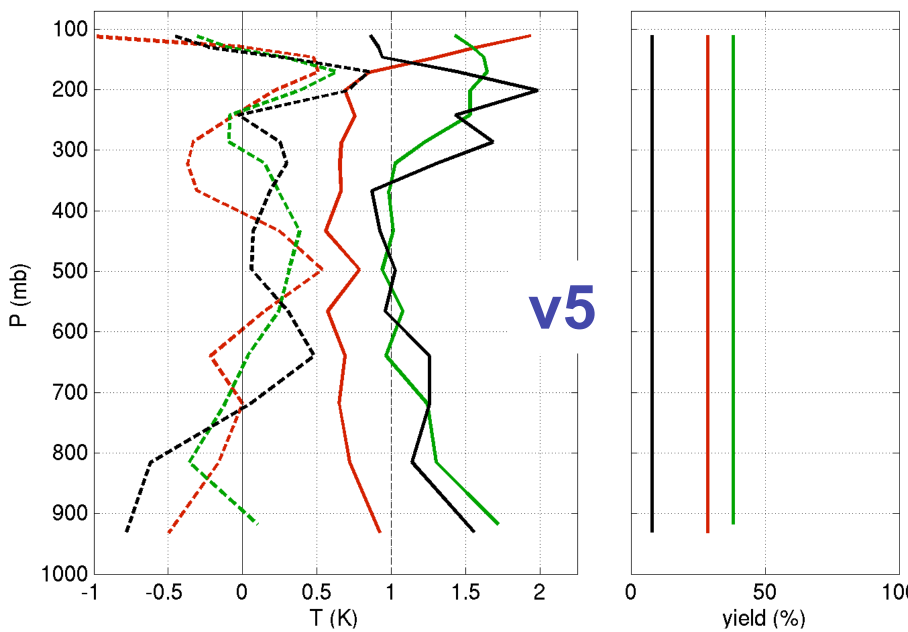
(i.e. Black: Temperature at all levels, H2O, and Surface* best quality)

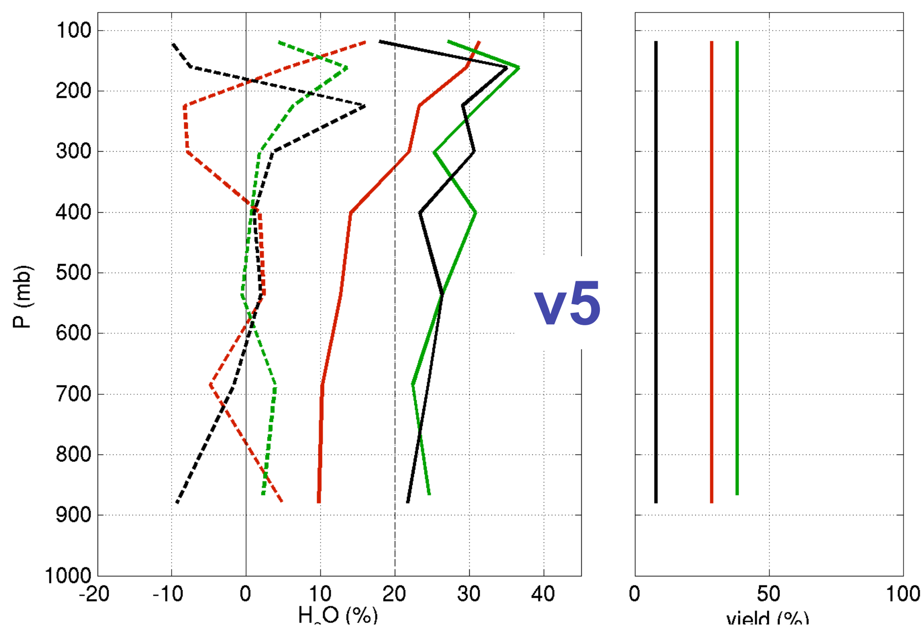
TWP
SGP
NSA

Dashed: Bias
Solid: RMS



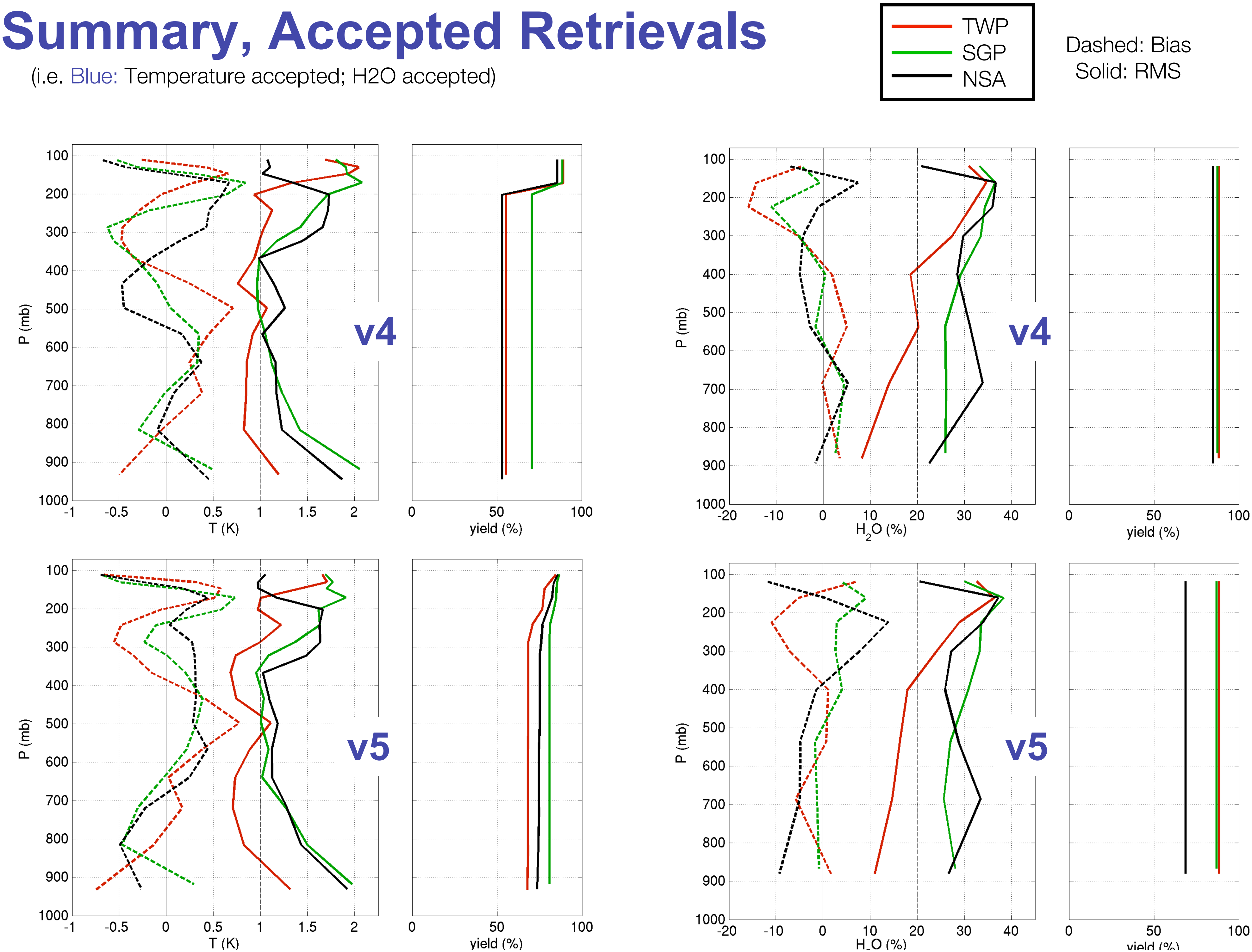




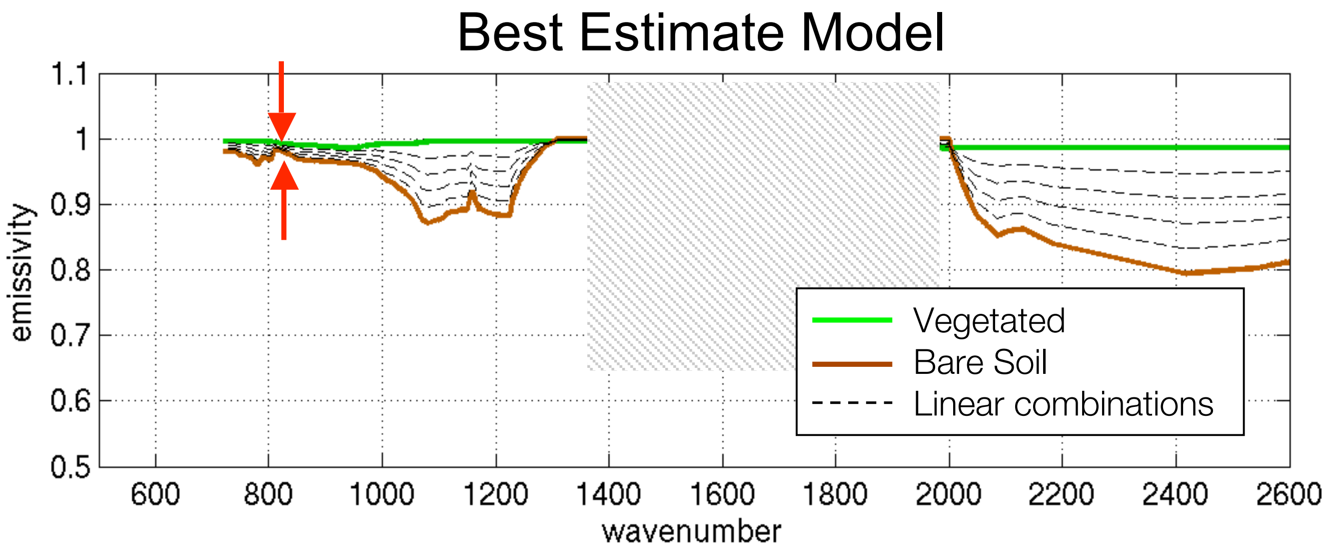


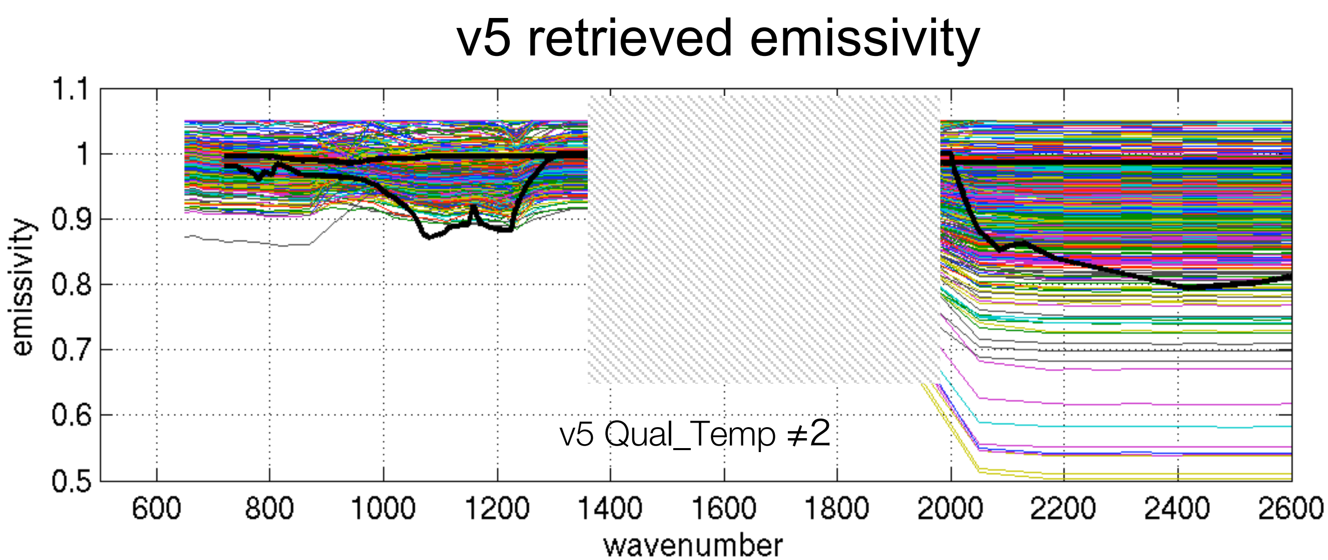
Summary, Accepted Retrievals

(i.e. Blue: Temperature accepted; H2O accepted)

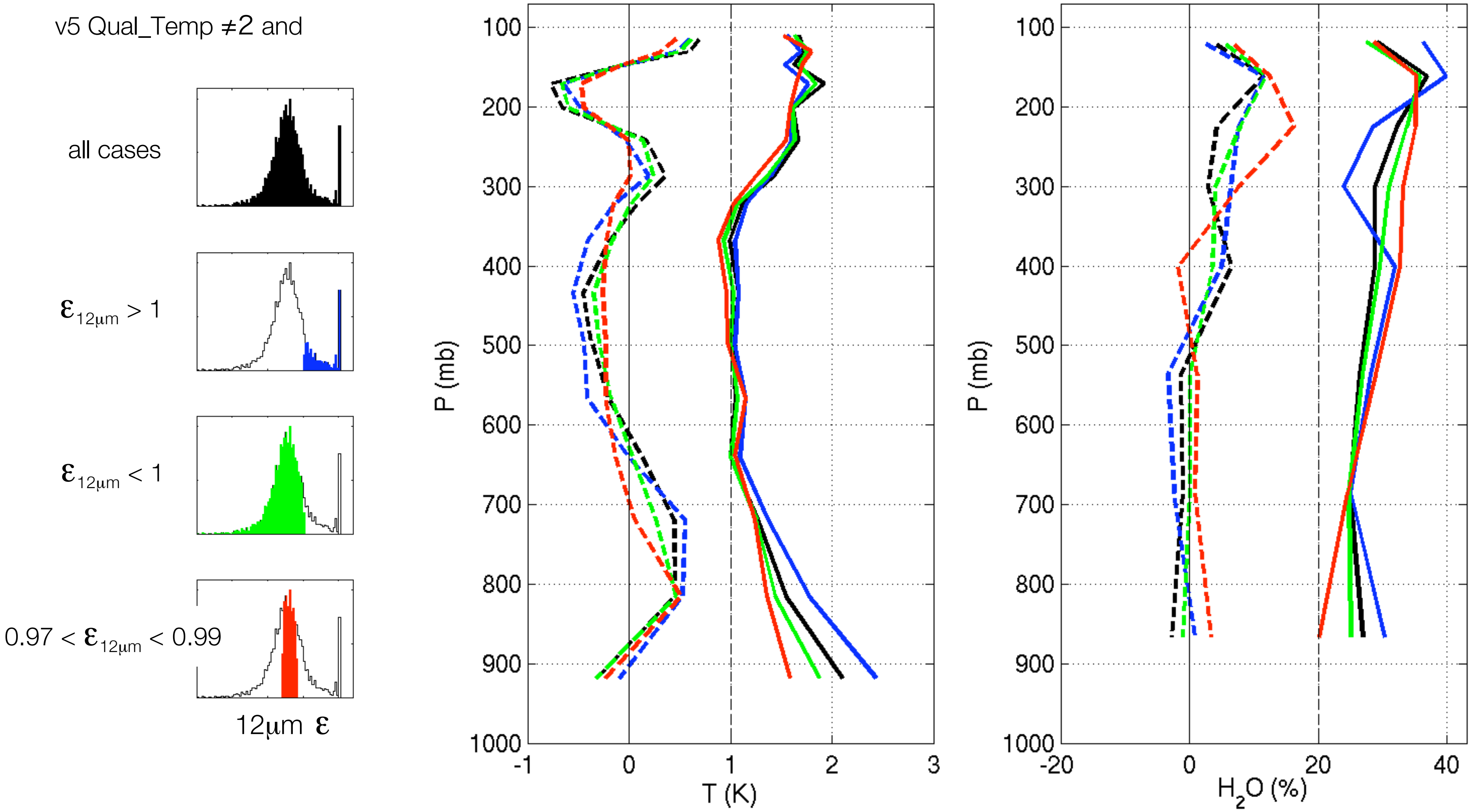


SGP, Land Surface Emissivity





SGP, Dependence of Retrieval Performance on Emissivity



Significant improvement in lower trop RMS for both T and q when the retrieved $\varepsilon_{12\mu m}$ is within range of SGP best estimates

Summary

- v5 RMS
  - Generally, the v5 retrieval performance (RMS) is similar to or slightly better than v4, but with increased yields
  - NSA site performance is similar to SGP (!)
  - v5 retrievals are generally meeting the 1K/1km and 20%/2km at TWP, but not at SGP and NSA
- Mean Biases
  - v5 biases wrt ARM are generally smaller than v4
  - T changes at SGP and NSA
  - v5 upper level H_2O 10-15% moister than v4
- Land Surface emissivity
  - v5 SGP T/q retrievals show significantly improved performance when the retrieved $\varepsilon_{12\mu m}$ is physical

Misc

- Next dedicated sonde launch phase
  - Funding (via Dave Starr) for 90 launches at each of 3 sites
  - Split 50/50 between Aqua and METOP-A overpasses
  - Start after IASI L1 processing is stable; revisit start dates in early May

- Probable closure of ARM site at Nauru